

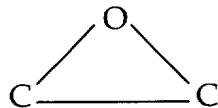
## CLAIMS

What is claimed:

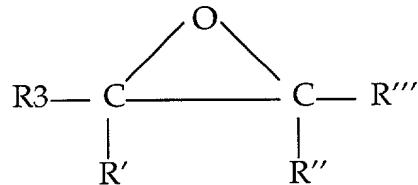
1. A no-flow underfill material comprising:
  - an epoxy siloxirane resin;
  - at least one agent acting as a cross-linking hardener and a curing catalyst capable of catalyzing the curing of the epoxy resin; and
  - a fluxing agent.
2. The material of claim 1 wherein the siloxirane resin is represented by
$$R_1 — R_3 — R_2$$
where R1 includes  $\text{SiO}_2$ 
  - R2 is a reactive organic functional group, and
  - R3 is an organic chain segment
3. The material of claim 2 wherein R1 is a surface-grafted fused silica particle with a size less than 50 microns.
4. The material of claim 3 wherein R1 is a cyclic  $\text{SiO}_2$  domain.

5. The material of claim 2 wherein R1 includes an oxygen atom linked to the silica particle, R3 being linked to the oxygen atom.

6. The material of claim 2 wherein R2 includes the oxirane group:

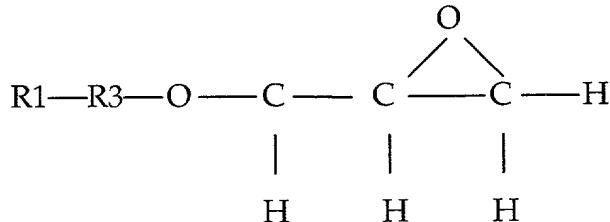


7. The material of claim 6 wherein R2 and R3 are represented by:

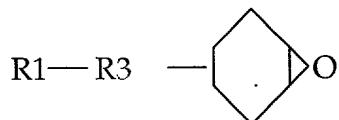


Wherein R', R'', and R''' are hydrogen or alkyl groups.

8. The material of claim 7 wherein R1, R2 and R3 are represented by:



or

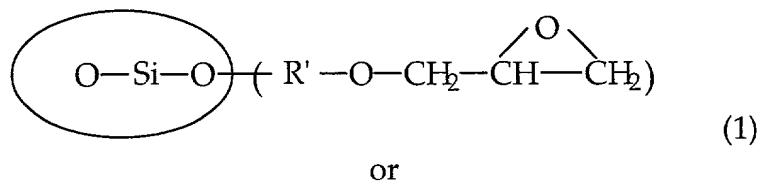


9. The material of claim 1 wherein the agent acting as a cross-linking hardener and a catalyst includes both a hardener and a catalyst.

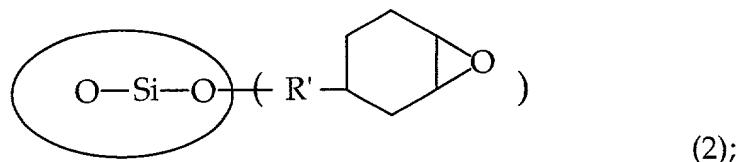
10. The material of claim 1 wherein the cross-linking hardener is selected from the group consisting of an imidazole and its derivatives, an amine, a triphenylphosphine, an anhydride, a polyamide, a polyamide amine, a phenolic resin, and an onium salt.
11. The material of claim 1 wherein the catalyst is selected from the group consisting of an imidazole and its derivatives, an imidazolium salt, a triphenylphosphine, a tertiary amine, and an onium salt.
12. The material of claim 1 wherein the fluxing agent is dissolved in a mixture of the resin and the agent.
13. The material of claim 1 wherein the fluxing agent is selected from the group consisting of an organic carboxylic acid, a polymeric fluxing agent, and an organic compound that contains one or more hydroxyl groups.
14. The material of claim 1 further comprising:  
an adhesion promoter.
15. The material of claim 14 wherein the adhesion promoter is selected from the group consisting of a silane coupling agent, an organo-zirconate, and an organo-titanate.

16. The material of claim 1 further comprising:  
a non-ionic surfactant.
17. The material of claim 16 wherein the surfactant is polyol, a siloxane compound, and a fluorinated compound.
18. The material of claim 1 further comprising:  
fused silica.
19. The material of claim 1 further comprising:  
silver flakes.
20. The material of claim 1 further comprising:  
thermally conductive particles.  
  
21. The material of claim 20 wherein the thermally conductive particles include a material selected from the group consisting of silicon nitride, silicon borate, alumina, diamond, and silicon oxide.
22. A no-flow underfill material comprising:

an epoxy siloxirane resin represented by



or



at least one agent acting as a cross-linking hardener and a curing catalyst capable of catalyzing the curing of the epoxy resin; and  
a fluxing agent.

23. The material of claim 22 further comprising:

an adhesion promoter;

a non-ionic surfactant;

fused silica;

silver flakes; and

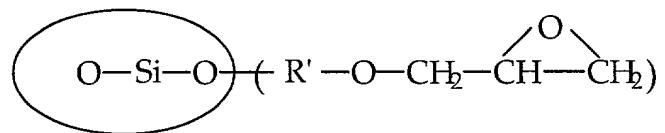
thermally conductive particles.

24. The no-flow underfill material of claim 22 wherein the agent acting as a cross-linking hardener and a catalyst includes both a hardener and a catalyst.

25. A semiconductor package comprising:

a package substrate;  
bond pads on the substrate;  
a semiconductor die;  
contact pads on the semiconductor die;  
a respective conductive bump on each contact pad, the die being located so that each bump is in contact and attached to a respective bond pad; and  
an underfill material filling regions between the bumps and including at least an epoxy siloxirane resin.

26. The semiconductor package of claim 25 wherein the epoxy siloxirane resin is represented by:



or

